Physicsaholics

DPP – 3 (Sound Wave)

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Q 1. A closed organ pipe and an open organ pipe of same length produce four beats in their fundamental mode when sounded together. If length of the open organ pipe is increased, then the number of beats will:
(a) increase (b) decrease
(c) remain constant (d) may increase or decrease

Q 2. For a certain organ pipe three successive resonance frequencies are observed at 425 Hz, 595 Hz and 765 Hz respectively. If the speed of sound in air is 340 m/s, then the length of the pipe is
(a) 2.0 m (b) 0.4 m (c) 1.0 m (d) 0.2 m

Q 3. If λ_1, λ_2 and λ_3 are the wavelengths of the waves giving resonance with the fundamental, first and second overtones respectively of a closed organ pipe. Then the ratio of wavelengths $\lambda_1 : \lambda_2 : \lambda_3$ is:
(a) 1: 2 : 3 (b) $1 : \frac{1}{3} : \frac{1}{5}$ (c) 1 : 3 : 5 (d) 5 : 3 : 1

Q 4. A sufficiently long closed organ pipe has a small hole at its bottom. Initially the pipe is empty. Water is poured into the pipe at a constant rate. The fundamental frequency of the air column in the pipe:
(a) continuously increases
(b) first increases and then becomes constant
(c) continuously decreases
(d) first decreases and then becomes constant

Q 5. Two pipes have each of length 2 m. One is closed at one end and the other is open at both ends. The speed of sound in air is 340 m/s. The frequency at which both can resonate is?
(a) 340 Hz (b) 510 Hz (c) 42.5 Hz (d) None

Q 6. An open organ pipe of length l is sounded together with another open organ pipe of length l + x in their fundamental tones. Speed of sound in air is v. The beat frequency heard will be (x << 1):
(a) $\frac{vx}{4l^2}$ (b) $\frac{vl^2}{2x}$ (c) $\frac{vx}{2l^2}$ (d) $\frac{vx^2}{2l}$

Q 7. If l_1 and l_2 are the lengths of air column for the first and second resonance when a tuning fork of frequency n is sounded on a resonance tube, then the distance of the antinode from the top end of the resonance tube is:
(a) $2(l_1 - l_2)$ (b) $\frac{1}{2}(2l_1 - l_2)$ (c) $\frac{1}{2}(l_2 - 3l_1)$ (d) $\frac{1}{2}(l_2 - l_1)$

Q 8. A tuning fork of 512 Hz is used to produce resonance in a resonance tube experiment. The level of water at first resonance is 30.7 cm and at second resonance is 63.2 cm. If actual velocity bof sound is 330 m/sec, the error in calculating velocity of sound is
(a) 204.1 cm/s (b) 110 cm/s (c) 58 cm/s (d) 280 cm/s

Q 9. In a resonance-column experiment, a long tube, open at the top, is clamped vertically. By a separate device, water level inside the tube can be moved up or down. The section of the tube from the open end to the water level acts as a closed organ pipe. A vibrating tuning fork is held above the open end, and the water level is gradually pushed down. The first and the second resonance's occur when the water level is 24.1 cm and 74.1 cm respectively below the open end. The diameter of the tube is
(a) 2 cm (b) 3 cm (c) 4 cm (d) 5 cm

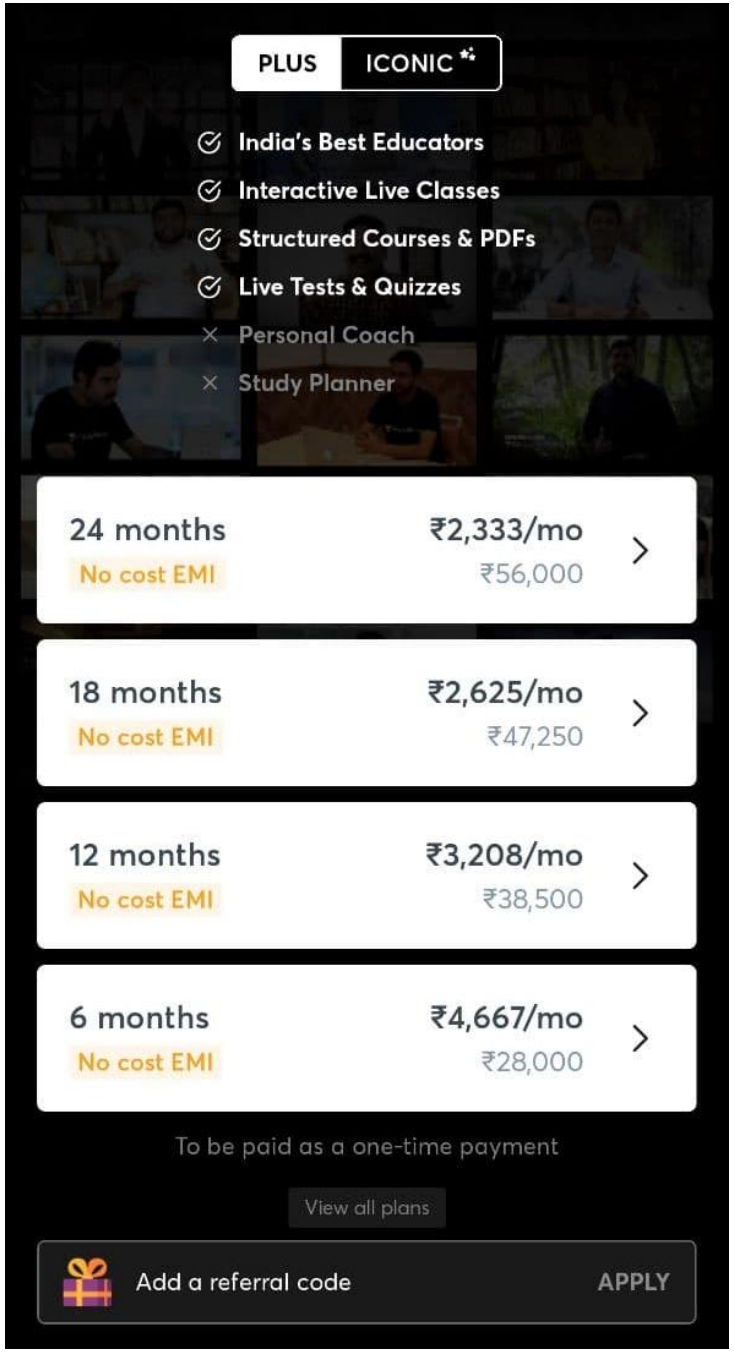
Q 10. A vibrating string produces 2 beats per second when sounded with a tuning fork of frequency 256 Hz. increasing the tension in the string produces 3 beats per second. The initial frequency of the string may have been
(a) 253 Hz (b) 254 Hz (c) 258 Hz (d) 259 Hz

Q 11. There is set of 4 tuning forks, one with lowest frequency vibrating at 552 Hz. By using any two forks at time, the beat frequencies heard are 1, 2, 3, 5, 7, 8. The possible frequencies of other three forks are
(a) 553,554 and 560 Hz (b) 553,555 and 560 Hz
(c) 553,556 and 558 Hz (d) 551,554 and 560 Hz

Q 12. Two sound waves of frequencies 300 Hz and 306 Hz are propagating in same medium. Frequency of resultant wave is
(a) 6 Hz
(b) 300 Hz
(c) 306 Hz
(d) 303 Hz

Answer Key

Q.1 d	**Q.2 c**	**Q.3 b**	**Q.4 b**	**Q.5 d**
Q.6 c	**Q.7 c**	**Q.8 d**	**Q.9 b**	**Q.10 b, c**
Q.11 b	**Q.12 d**			



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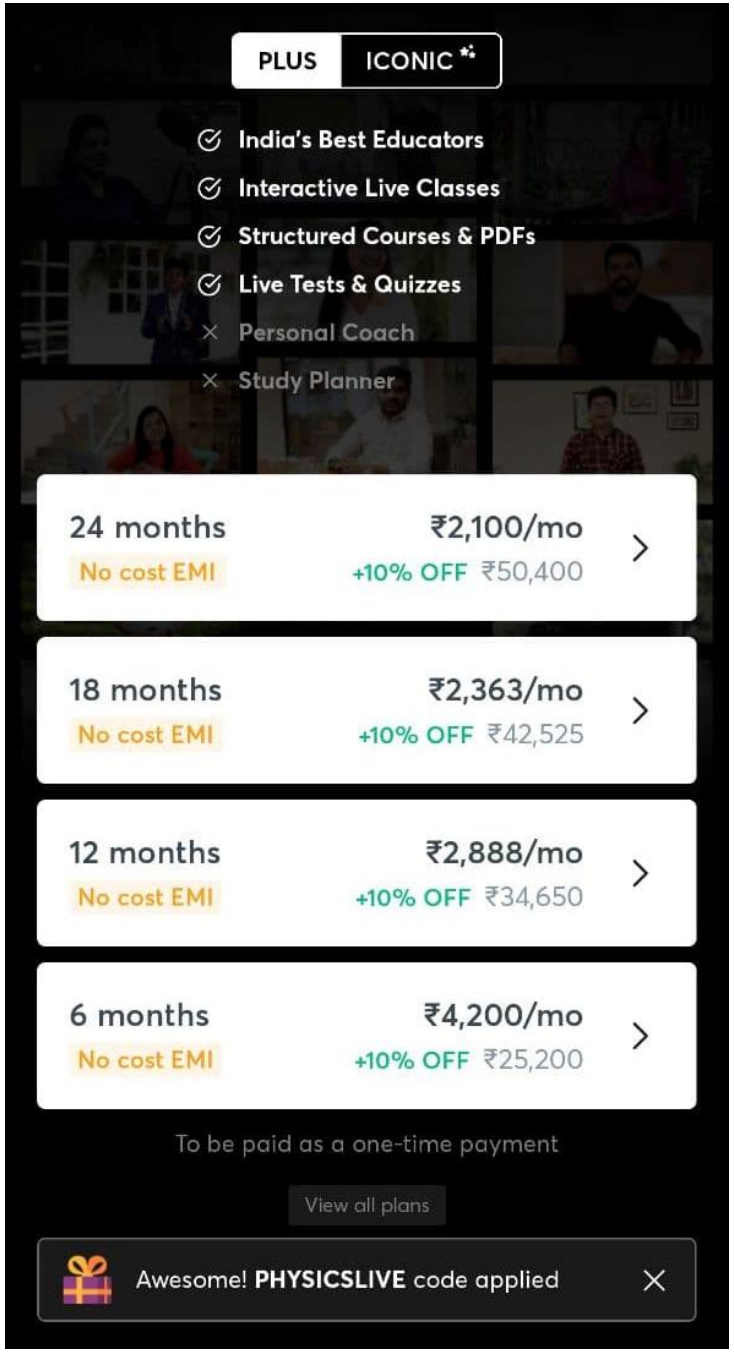


Written Solution

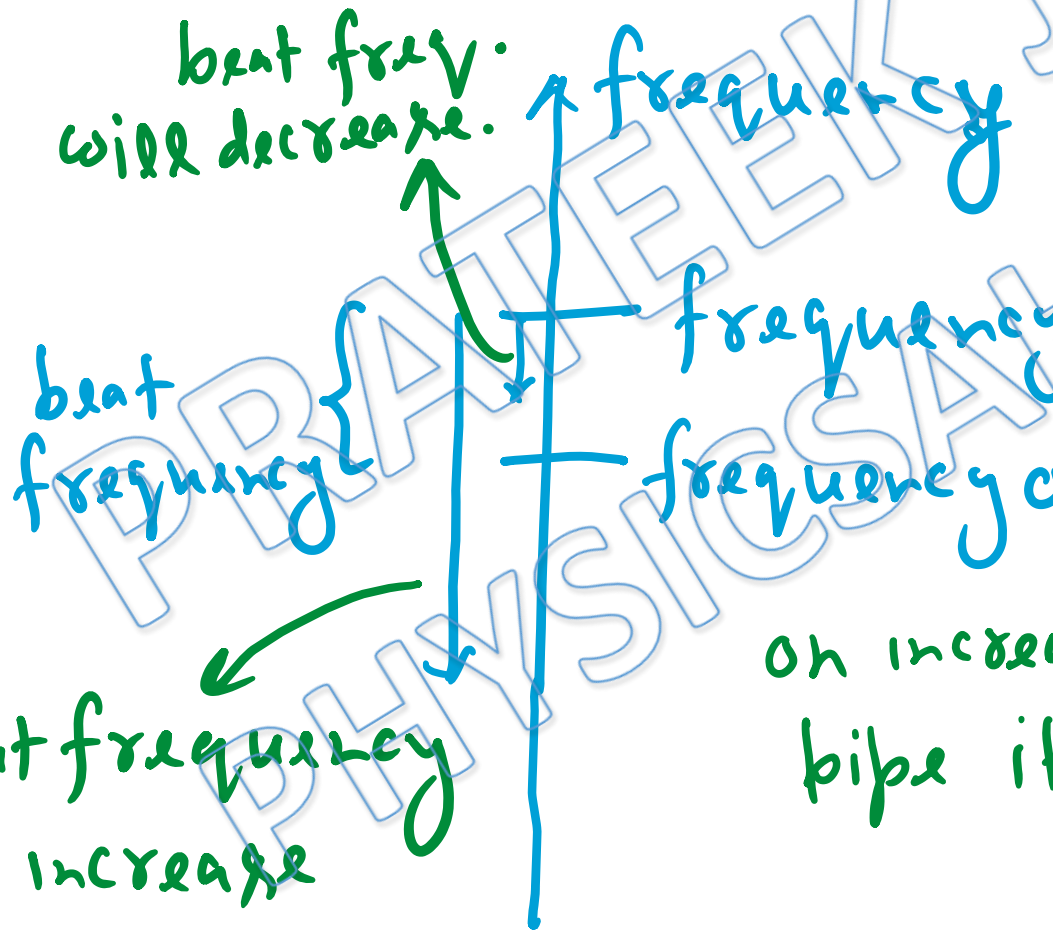
DPP- 3 Sound : Standing Sound Waves & Beats

By Physicsaholics Team

1)

frequency of closed organ pipe $= \frac{V}{4\ell}$

" " open " " $= \frac{V}{2\ell}$



on increasing length of open organ pipe its frequency will decrease.

Ans (d)

2)

n_1 th harmonic $\Rightarrow n_1 f_0 = 425$ (→ fundamental)

n_2 th. " $\Rightarrow n_2 f_0 = 595$

$\Rightarrow \frac{n_2}{n_1} = \frac{595}{425} = \frac{119}{85} = \frac{7}{5}$

$\Rightarrow n_1 = 5$, $n_2 = 7$ & pipe is closed organ.

$\Rightarrow 5 f_0 = 425 \Rightarrow f_0 = 85$

$f_0 = \frac{V}{4\ell} \Rightarrow \ell = \frac{V}{4 f_0} = \frac{340}{4 \times 85} = 1\,m$

Ans (c)

3)

for closed organ pipe

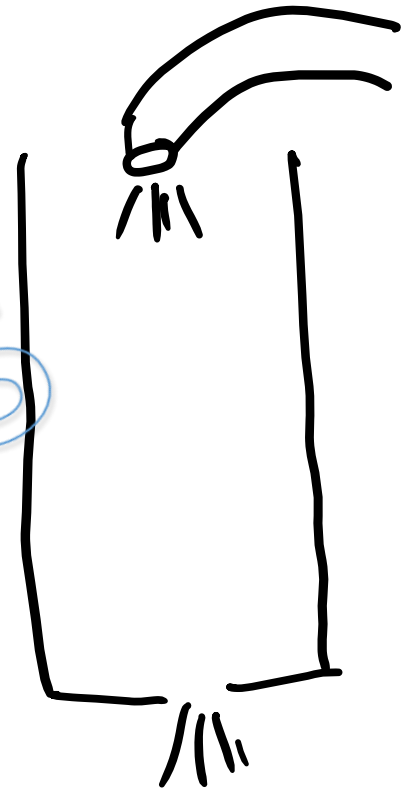
$$f_1 : f_2 : f_3 = 1 : 3 : 5$$

$$\Rightarrow \frac{v}{\lambda_1} : \frac{v}{\lambda_2} : \frac{v}{\lambda_3} = 1 : 3 : 5$$

$$\Rightarrow \lambda_1 : \lambda_2 : \lambda_3 = 1 : \frac{1}{3} : \frac{1}{5}$$

Ans(b)

4) As the water level in pipe increases velocity & Rate of water going out from hole increases. when Rate of water coming from pipe & rate of water outgoing from hole become equal, height of water becomes Constant.



⇒ length of air colum firs decreases then becomes Constant

⇒ fundamental frequency first increases " " "

ANS(b)

5) Let n_1th harmonic of closed and n_2th harmonic of open are equal.

$$n_1 \frac{v}{4\ell} = n_2 \times \frac{v}{2\ell}$$

(n_1: integer; n_2: odd)

$$\frac{n_1}{n_2} = \frac{1}{2}$$

(n_1: odd) $\Rightarrow$ not possible

Ans (d)

6)

$$\text{Beat frequency} = \frac{V}{2\ell} - \frac{V}{2(\ell+x)}$$

$$= \frac{V}{2}\left[\frac{1}{\ell} - \frac{1}{\ell+x}\right]$$

$$= \frac{V}{2}\left[\frac{\ell+x-\ell}{\ell(\ell+x)}\right]$$

$$= \frac{Vx}{2\ell(\ell+x)}$$

$$= \frac{Vx}{2\ell^2} \quad \text{Since } x \ll \ell$$

Ans(d)

7)

for first resonance

$$l_1 + e = \lambda/4$$

for Second resonance

$$l_2 + e = 3\lambda/4$$

$$3l_1 + 3e = 3\lambda/4$$

$$(3l_1 - l_2) + 2e = 0$$

$$e = \frac{l_2 - 3l_1}{2}$$

Ans(b)

8)

$$V = 2f(l_2 - l_1)$$

$$= 2 \times 512 \times (63.2 - 30.7)\ \text{cm/sec}$$

$$= \frac{1024 \times 32.5}{100}\ \text{m/sec}$$

$$= 332.8\ \text{m/sec}$$

Actual velocity = 330 m/sec

Error = 2.8 m/sec

Ans (d)

9) End Correction in resonance column experiment

$$e = \frac{l_2 - 3l_1}{2} = 1.5d$$

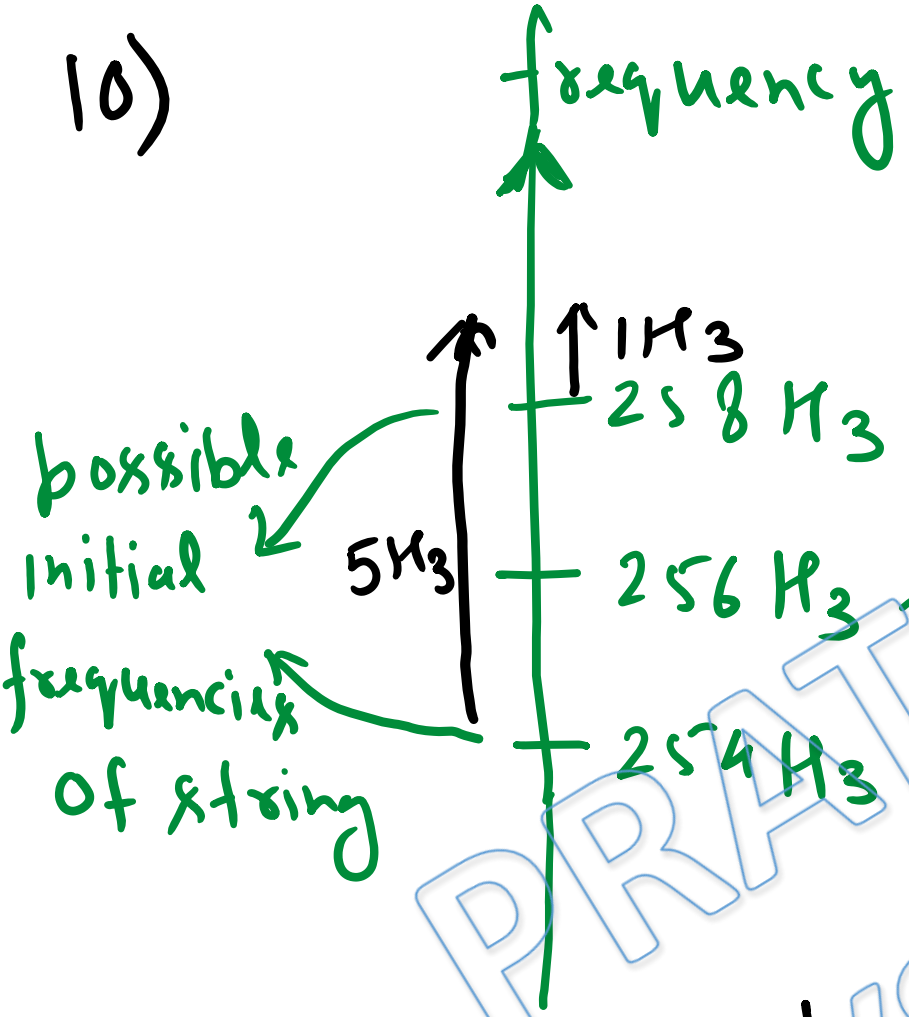
$$\Rightarrow d = \frac{l_2 - 3l_1}{1.6} = \frac{74.1 - 3 \times 24.1}{1.6}$$

$$= \frac{74.1 - 72.3}{1.6}$$

$$= \frac{1.8}{1.6} = 3\ \text{cm}.$$

Ans (b)

10)



On increasing tension frequency of string will increase.

In both cases (254 Hz & 258 Hz) final beat frequency may be 3.

Ans. b, c

11)

Beat frequencies = 1, 2, 3, 5, 7, 8

? → beat freq = 3. for Beat frequency 1

frequency of 1 tuning fork must be 260 Hz.

Ans (b)

12)

Frequency of resultant wave (beat wave)

$$= \frac{f_1 + f_2}{2}$$

$$= \frac{300 + 306}{2}$$

$$= 303 \text{ Hz}.$$

Ans. d

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